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MICROMINERALOGICAL AND TEXTURAL FEATURES IN RELATION TO THE GENESIS OF BAUXITE OF ISZKASZENTGYÖRGY

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INTRODUCTION

The task of the present paper is to study within profiles of a single bauxite body the genetically evaluable relations between the quantity of the accessory detrital minerals and the textural features of the bauxite.

The samples selected for this study comprise the total bauxite profile of six productive boreholes of the Rákhegy bauxite body, Iszkaszentgyörgy (Bakony Mountains, Hungary). The boreholes are arranged in dip and strike direction of the bauxite deposit. The samples are as follows (enumerated downwards):

Borehole Rp—19: Samples Nos. 1 to 13
Rp—40: Samples Nos. 14 to 19
Rp—30: Sample No. 20
Rp—17: Samples Nos. 21 to 32
Rp—26: Samples Nos. 33 to 39
Rp—23: Samples Nos. 40 to 46

The geology of the area is as shown on *Fig. 1.*

The bauxite body of Rákhegy is bordered from the József deposit to the south by a tectonic fault, from here it is extended to NNE, in 2,5 km length; its average width is 400 m, the average dip is 0/10°, the thickness average is 5,9 m. The deposit lies on the karstic surface of the Carnian "Hauptdolomit", usually with an intervening dusting dolomitic zone. The bauxite body is paraconformably overlain by the transgressive Upper Lutetian coal-bearing sequence.

MICROMINERALOGICAL STUDIES

In order to find out quantitative distribution of the accessory detrital minerals along profile, the 0,2—0,1 mm diametre range of 45 bauxite samples have been treated. On the basis of the random samples derived from the other grain-size intervals, the mineral percentage composition of these latter is nearly the same as that of the 0,2—0,1 mm diametre range. The exception is the coarsest (0,63—0,32 mm) fraction, but its quantity is negligible when compared to the total amount of the settling rest.

The partly optically, partly X-ray analitically recognizable minerals are shown in *Fig. 2.* These minerals with their probable origin is summarized in Table I. In addition to the previously known minerals [KOMLÓSSY, 1969] the following new minerals could have been proved: lithiophorite, zircon, spessartine, staurolite, glauconite and spinel.

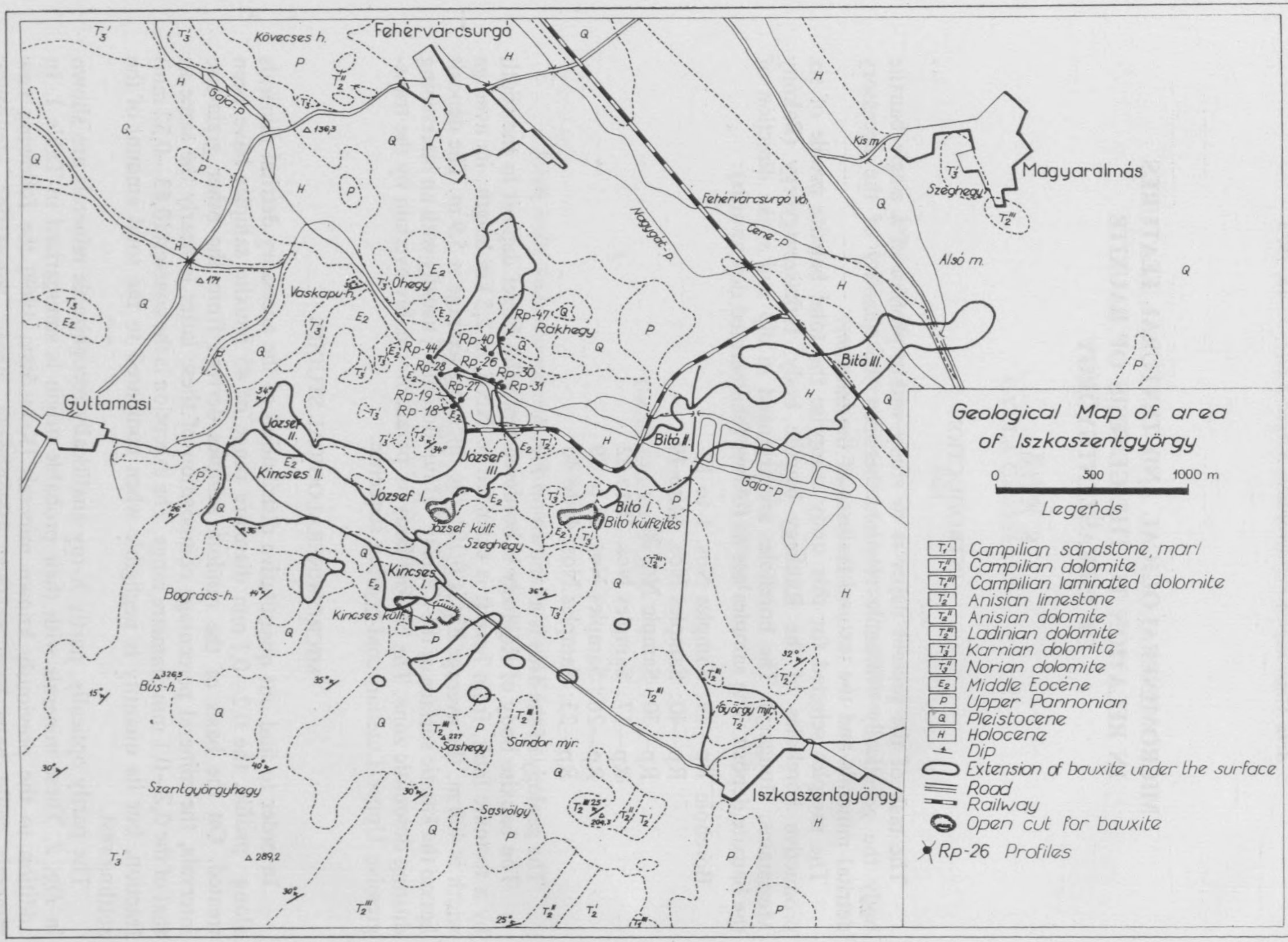

Fig. 1. Geological map of the bauxite area of Iszkaszentgyörgy.

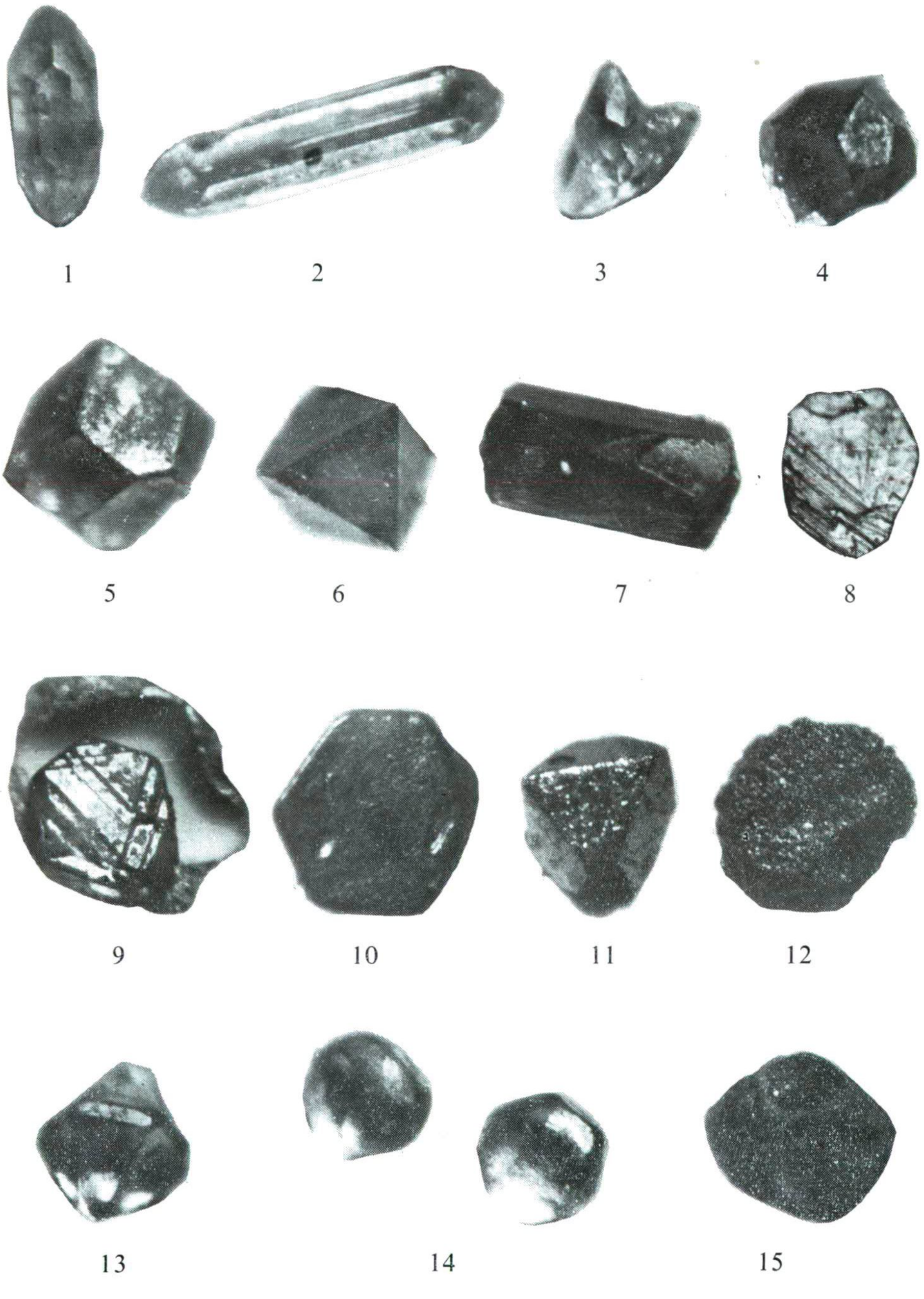

Fig. 2. Some clastic minerals from the settling rest of the bauxite. *1—3.* Zirkon. *4—5.* Spessartin. *6.* Spinel. *7.* Tourmaline. *8—9.* Corundum. *10—12.* Ferriilmenit. *13.* Intact dihexaedral quartz. *14.* Rounded quartz grains. *15.* Internal filling of shells by glauconite.

Table 1

Epigenic	Doubly or severally redeposited	Magmatic	Metamorphic
m i n e r a l s			
Pyrite	Quartz	Quartz	Quartz?
Gypsum	Turmaline	Turmaline?	Turmaline?
Goethite	Spessartine	Muscovite?	Spessartine?
Lithiophorite	Staurolite	Biotite?	Staurolite
Rutile	Ferriilmenite	Ferriilmenite	Muscovite
Ferriilmenite?	Muscovite	Rutile?	Chlorite?
Zircon?	Biotite	Zircon	Spinel
Corundum?	Chlorite	Spessartine?	Corundum?
	Dolomite		Rutile?
	Glauconite		
	Corundum		
	Rutile		
	Zircon		

It is clear from Table 1 that unless the case of the idiomorphic, dihexahedral quartz and also idiomorphic spinel, staurolite, zircon, ferriilmenite and possibly corundum, the immediate origin from magmatic or metamorphic rocks is doubtful, because the heavily rounded (i.e. perhaps doubly or severally reworked) grains of the mentioned minerals are also present. Moreover, the epigenic formation of the zircon cannot be precluded, since epigenic zircon was recorded from other sedimentary rocks (e. g. sandstones) [Saxena, 1964]. Epigenic zircon formation is suggested by the idiomorphic, fragile, acicular appearance together with the heavily rounded grains within the same sample, precluding here the possibility of transport. The epigenic corundum formation have been indicated (ICSOBA). The epigenic origin for this mineral is suggested by the grains of "graded" structure referred to overgrowing. The ferriilmenite and the dihexahedral quartz can be originated from the Middle Eocene amfibole-andesite tuffs known at Halimba, and from intrusive rocks, respectively. Though the bauxites lack the favourable conditions for epigenic ferriilmenite formation [Mindszenty, 1970], even this possibility cannot be rejected. The majority of the minerals can be derived partly from sedimentary (mainly Lower and Middle Eocene and subordinately Mesozoic) rocks, and partly came after a shorter or longer bauxitic weathering, or transported as immediate detritus of siallitic-allitic magmatic or metamorphic rocks. It is worth to mention here the studies of Szabó—Ravasz [1970], who suggested the Middle Triassic volcanic (tuffitic) material as the parent rock of the bauxites of the Transdanubian Central Mountains.

Fig. 3 shows the quantitative distribution diagrams. Within the certain proper weight percent intervals the quantity of the 0,2—0,1 mm fraction is nearly identical within the same horizons of the bauxite body. In the deeper horizons amounts to 0,05%; increasing upwards, where a horizon of 0,05—0,1% value can be recognized. In Profile 1 within the middle portion of the bauxite body a considerable enrichment appears, attaining its greatest value in Borehole Rp—27, but decreasing to 0,1—0,4% on both sides of this borehole. Going further upwards the quantity of the minerals decreases again and attains a value equivalent to that in the basal part of the body. In this upper part the enrichment is occasional (Boreholes Rp—23;

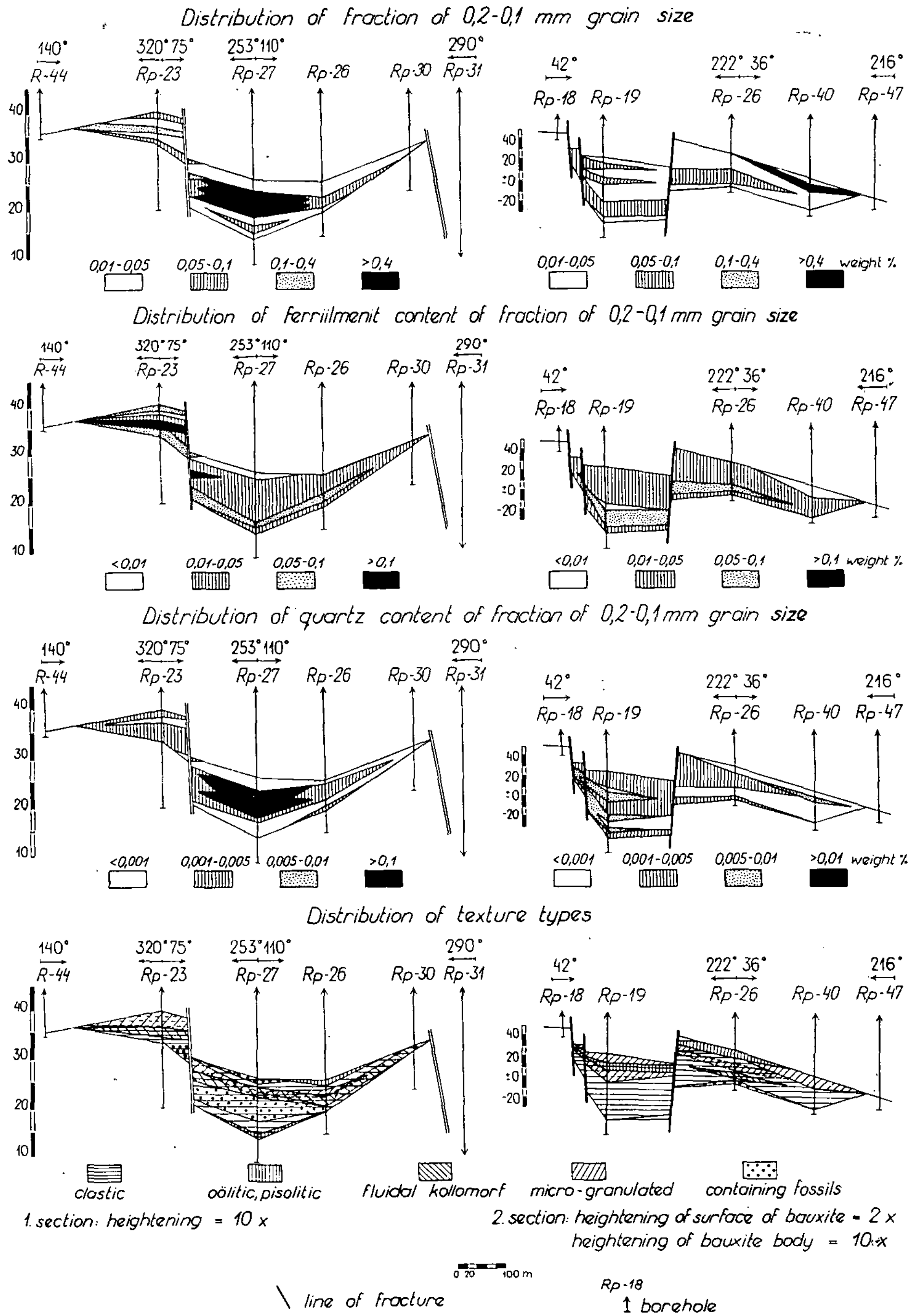

Fig. 3. Distributional sections.

Rp—40) and can be due to the epigenic pyrite content of the grey bauxite and therefore non-detrital in character. The mineral content of the thicker portions of the bauxite body shows further irregularities (e.g. in Borehole Rp—19).

From the minerals of this fraction only the ferriilmenite and the quartz, those of definitive quantity, were studied in detail. The distribution of the ferriilmenite is relatively regular, most common is the 0,01—0,05% quantity. It enriches in the lower part of the bauxite body, and except in Borehole Rp—23, usually decreases upwards gradually. Its distribution somewhat corresponds (especially in Profile 2) to the total amount of the fraction. The distribution of its values are relatively unvarying.

The distribution of the quartz is more changeable as compared to that of the ferriilmenite, and strikingly corresponds to the distribution of the total amount of the fraction.

The distribution of the other minerals — owing to their small quantity — unworthy for figuring, however, remarkable the distribution of the spessartine, being similar to that of the quartz.

Thus in the middle portion of Profile 1 of strike direction appears a remarkable detrital enrichment, and this is traceable in Profile 2 of dip direction. In this belt the detritus consists of quartz, glaukonite and spessartine, with an oscillative distribution of the detritus and the quartz within that. On the basis of the distribution along the profile a detrital transport towards NE direction can be expected, i.e. the belt of detritus of greatest quantity extends in this direction, across Borehole Rp—27.

TEXTURAL STUDIES OF THE BAUXITE

The basis for the textural nomenclature in thin-section textural studies is what have been outlined by BÁRDOSSY—PANTÓ [1970] in connection with their electron microprobe studies. On the other hand the two methods differ in an order of magnitude, i.e. the fine-structural features in thin-sections are indistinguishable, but these are traceable with the microprobe. But similar and even some identical textural types were recognizable in thin-sections and with the microprobe as well.

The identified textural types were: pelitomorphic, micro-grained, collomorphic-fluidal, spotted, brecciated and detrital. These are usually mixed, with a dominant type and some associated subordinate ones. Commonly the micro-grained and the pelitomorphic types are inseparable. This terms bear certain genetical meaning too, suggesting different energetic levels.

The bauxite of the Rákhegy locality is overwhelmingly of detrital texture, severally mixed with collomorphic features as additional type (Samples 20, 23, 37, 44), but subordinately oöides also appear (Samples 31, 20, 32). Pisoides and brecciated texture occured only in Samples 33 and 24. The ball-shaped grains are also common, but characteristically appear exclusively in Sample 32. The spotted texture occurs mainly in Borehole Rp—23. Also subordinate the micro-grained or micro-grained — pelitomorphic textural type, being represented only in Samples 1 and 15. The textural types are shown in *Figures 4, 5* and *6.*

The detailed review of the textural elements is given below.

Bauxitic detritus

Size between 10 and 2000 micron. Most common is the sharp, highly ferritic (hematitic) detritus *(Fig. 4/1a)*. Subordinately, but all in the detrital samples the

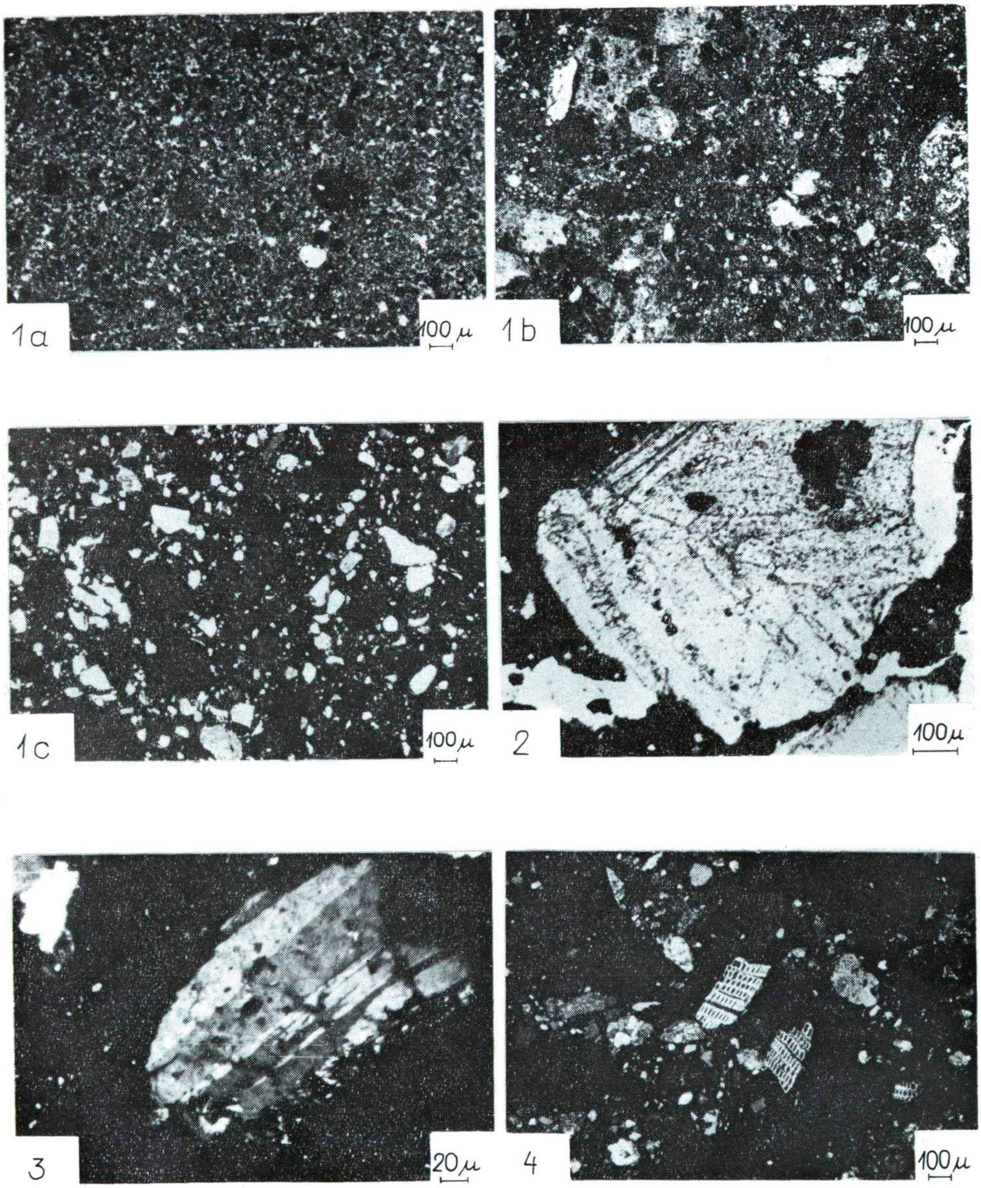

Fig. 4. 1a-c. Bauxite of clastic texture. *2.* Nummulites from the Sample No. 39/b. *3.* Strongly weathered feldspar (Sample No. 24/c.) *4.* Fragments of Bryozoan and rocks (Sample No. 25/a).

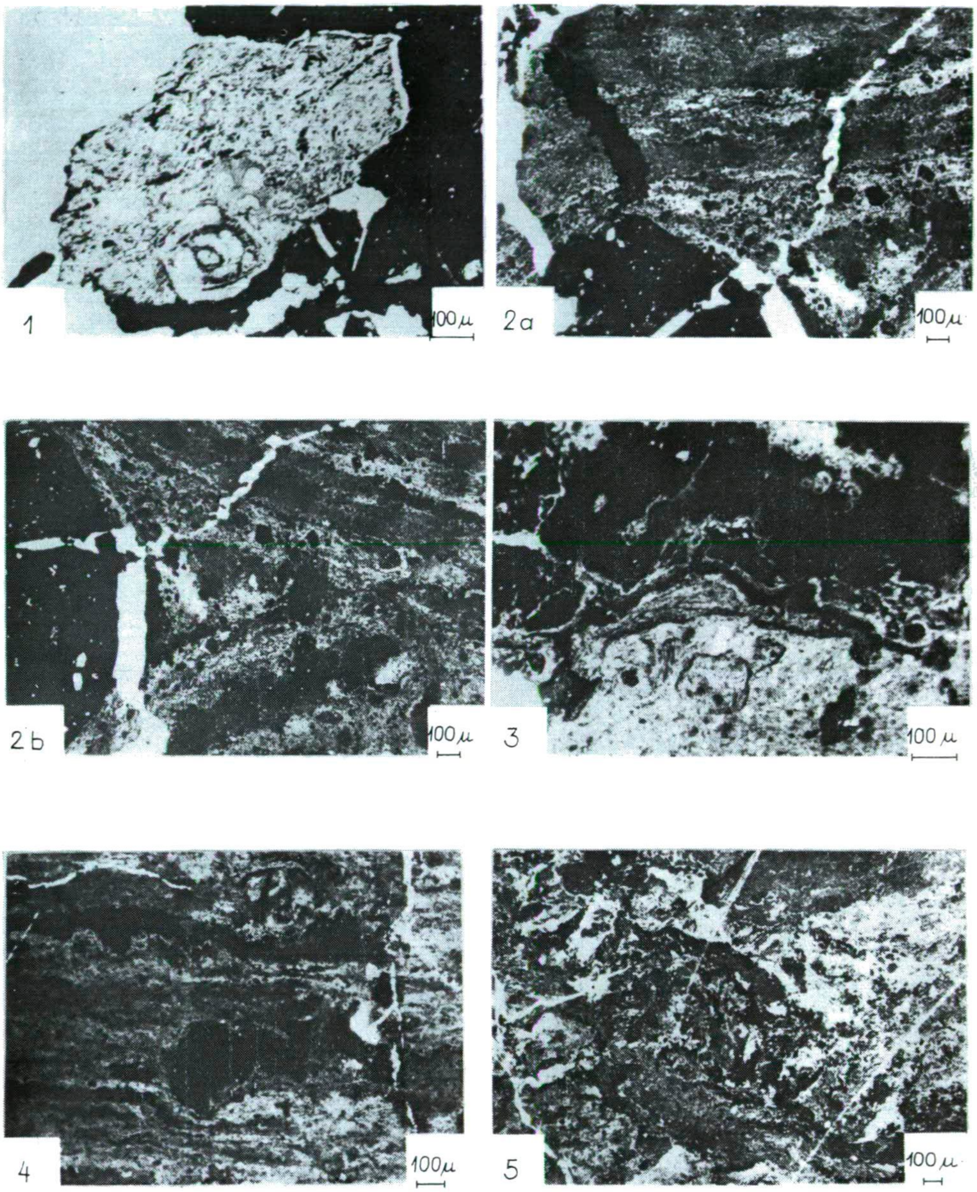

Fig. 5. 1. Fragments of limestone with Miliolina and Bryozoans. *2a-b.* Fluidal texture (Sample No. 37). *3.* Collomorphy precipitation of gel of iron hydroxide (Sample No. 44). *4.* Lamination caused by fluidal texture (Sample No. 23). *5.* Congestion in fluidal texture (Sample No. 23.).

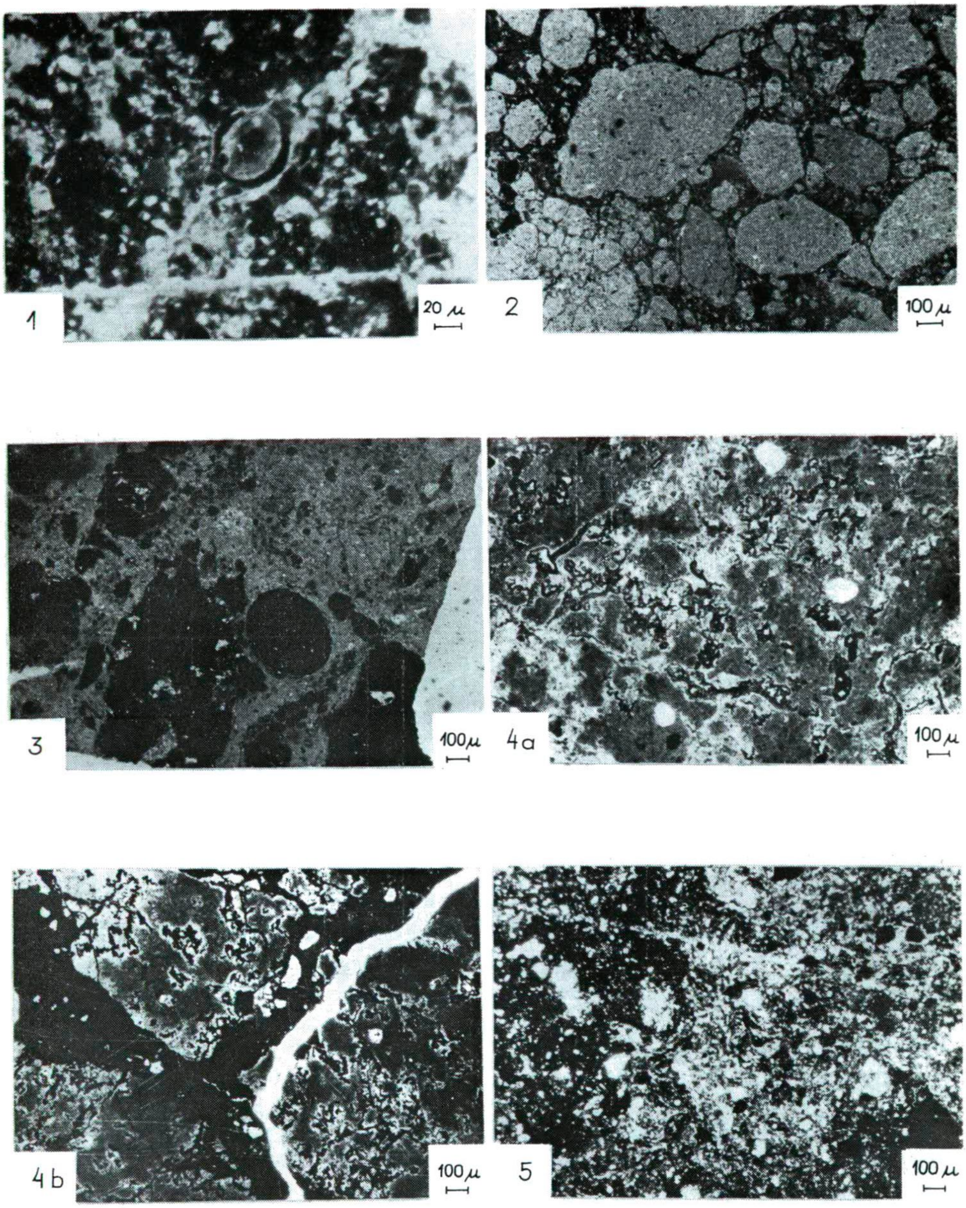

Fig. 6. 1. Oöide (Sample No. 20). *2.* Brecciated texture (Sample No. 24/a.) *3.* Ball-shaped grain (Sample No. 44). *4a-b.* Bauxite with spotted texture (Sample No. 24/a). *5.* Bauxite with kaolinite-contents (Sample No. 32/a).

yellow, yellow-brown, less ferritic detrital also represented, with more rounded shape, showing the more resistant nature of the latter, as compared to the hematitic one. Secondary iron layers encrusting some detrital grains also can be recognized.

Ball-shaped grains

Non characteristically, but frequently represented, especially in the samples from deeper portions. The majority is considerably of ferritic, but while the detrital grains are of hematitic, these spherical grains are often represented as brown, goethitic nodules *(Fig. 6/3)*. Size between 100—600 micron. The overwhelming angularity of the detritus seems to suggest a minor, short-distance, or an autochtonous redeposition, and the subordinate quantity of the shperical grains, *i.e.* the more rounded bauxitic detritus do not contradict this.

Non-bauxitic detritus

In the middle part of Borehole Rp—27 and in the basal part of Borehole Rp—26 appears a considerably clastic, fossiliferous zone *(Fig. 4/1c—4)*. These fossils (nummulites, miliolinids, other small forams, bryozoans) date the bauxite redeposition whithin the Eocene. The oldest overlying layer is of Lower Lutetian, thus the redeposition can be ranged into the Early Eocene or at the early Middle Eocene. Most likely the intralutetian denudation [Kopek—Kecskeméti, 1965] played an important role in this process. The unrounded nature of the detritus (calcite, dolomite, quartz, spessartine, rock-fragments) as well as the presence of calcitic shells indicate short-distance redeposition. On the basis of the basal appearance of the Eocene clastics in Borehole Rp—26, it is reasonable to conclude a redeposition of the underlying beds associated with the bauxite originally laid down on Eocene foot-wall.

Fluidal-collomorphic textural elements

Most common are the textures giving proof of a previous flowing movements in a presumed plastic state of the deposit *(Fig. 5/2a—b)*. In some cases appears stratification *(Fig. 5/4)*, in other cases the matrix "flows round" bigger bauxitic detritus. This phenomenon can be due to the impression of bigger grains into the matrix, or to the flow of the matrix transporting finer detritus round the bigger grains as well. Both of these causes can be recognized in Samples 20, 23 and 27. Collomorphic elements suggesting gelate state material movement and rhythmic precipitation can also be recorded, and can be originated from the presumably less viscous material *(Fig. 5/3)*. Occasionally congestive structure is also appeared *(Fig. 5/6)*. The matrix of the fluidal textural portions "carrying" the detrital grains is usually lighter (yellow), i.e. poorer in iron.

Oöides, pisoides

Pisoidic material exclusively appears in (uppermost) Sample 33 of Borehole Rp—26. The material of the pisoides is pyritic grey bauxite. The pisoides could indicate the beginning of the overflowing of the area by water. The sporadically occuring oöides partly are just initiatives *(Fig. 6/1)*, without distinct nuclei, with hematitic central part. The quantity and the primitive character of the oöides indicate a subordinate or autochtonous redeposition.

Brecciated texture

It is the characteristic textural type of Sample 24 *(Fig. 6/2)*. Probably it can be due to a post-, or final-redepositional process, because this kind of fragmentation impossible within a plastic material.

Spotted texture

This term have been used in the macroscopic descriptions, too. It refers to the irregular alteration of the light (poor in iron) and darker (richter in iron) spots in the bauxites. This type is well recognizable in several samples of Borehole Rp—23 and in Sample 24 *(Fig. 6/4a—b)*. In some places the light spots are penetrated by meandering small ferrous veins. This probably shows a diagenetic iron-mobilization. Thus the iron have mobilized during the formation of the spotted texture partly remained within the bauxite body and subsequently precipitated through the changed physico-chemical circumstances.

Kaolinite

The presence of the kaolinite considerably effects the rock-texture, though the kaolinite in itself is not an independent textural element. It is represented, with variable quantity, in the majority of the samples, forming nodules, grain-congeries, branching forms and disseminated grains. The nodules are everywhere present, the other forms are dominant in the lower, kaolinic portion of the bauxite body *(Fig. 6/5)*. The grain-size is 1 to 10 micron, the nodules are of several hundred micron in size. Vermicular forms are also common. Whether the kaolinite formed after or before redeposition hard to decide. The kaolinite of the detrital grains presumably came together with the detritus, but the disseminated and amorphous kaolinite of the lower kaolinitic bauxite is an autochtonous precipitation.

Fig. 3/d shows the distribution of the textural elements. The basis is the symbol of the detritus, while the symbols of the other textural elements (in the case of mixing) are taken onto this. Separately signed is the fossil layer. The distributional regularities recognized in the profiles are as follows:

1. The pisoidic textural element exclusively occurs in the grey bauxite, in the surface of the bauxite body, within a single borehole (Borehole Rp—26). In strike direction this is the deepest point of the bauxite body.

2. Oöides occur characteristically in the upper and in the basal part (Boreholes Rp—19 and Rp—27, respectively) of the bauxite body, exclusively in the detrital bauxite.

3. The fluidal-collomorphic textural elements appear in the middle and upper part of the bauxite body, exclusively under or at most mixed with the micro-grained bauxite (Borehole Rp—27). In a profile along strike direction it runs through the whole bauxite body, but in profile of dip direction it appears only in a single borehole (Borehole Rp—26).

4. Bauxite of purely micro-grained texture occurs only in the uppermost parts (Rp—19, Rp—40), where it forms the grey pyritic bauxite. In mixed types it appears also in the upper horizons and within both profils it runs through nearly the whole bauxite body.

5. The considerably detrital bauxite containing Lower or Middle Eocene fossils and rock-fragments can be found in the middle and lower parts of the profiles. In Borehole Rp—27 it occurs with a considerable thickness (6 metres), on the other hand in Borehole Rp—26 it appears only in the basal part. The pyritic bauxite of Borehole Rp—27 also contains mollusc shell-fragments, thus it can be considered as of detrital too, but it seems to be more possible that these fossils have derived from the swamps overlain the bauxite body in Middle Eocene times.

6. In the profiles some depositional tendency is also can be recognized. Namely the basal part of the bauxite is of considerably detrital (oöidic and partly fossiliferous). The detrital character partly constant and partly decreases upwards, and then appear the mixed types to the detriment of the detrital type. In some places the mixed types extend up to the surface, in other places the detrital material tends to subordinate, and even absent. Exception to the rule is the pisoidic bauxite of the uppermost part in Borehole Rp—26.

CONCLUSIONS

On the basis of its size and dimensions the bauxite body of Rákhegy deposited in an elongated, platter-like depression, with its possible deepest point in the vicinity of Borehole Rp—26. The material carried into this depression presumably derived from the erosional products partly of rocks (dolomites, limestones, marls, even previously bauxitized clays) of the surrounding area, and partly of rocks (metamorphic schists and magmatics) of distant regions. According to the presence of bauxitic detrital grains in the bauxite body, a redeposition of a previously deposited bauxite also can be supposed. Taking the textural features into consideration on the basis of the general picture of the distribution, a transportation belt of SSW to NNE direction can be assumed. The middle part of this belt is intersected by Borehole Rp—27. Taking the Eocene detrital material of Borehole Rp—26 into account, the direction of this belt can be of SE to NW. Presumably both are proper directions.

The bauxite of Rákhegy texturally is almost completely of detrital origination. This detrital character is a result of autochtonous redeposition in one hand and detrital afflux in the other. The more considerably detrital belt recognized within the bauxite body presumably shows the line of stronger water current. This detrital character of the Rákhegy bauxite contradicts the "terra rossa" theory of bauxite formation. The downward increasing detrital character supports the parautochtonous theory [Bonte, 1970]. According to this theory, in the course of the bauxitic material accumulation (*i.e.* during the infilling of the basin) the intensity of the water currents decreased, then the area was covered by intermittently stagnant waters, facilitating by the loosening the bauxitic material the autochtonous redeposition. Such a redeposition is also proved by the presence of great amount of unrounded bauxitic detritus. In this stage of bauxitization the bauxitic material is partly already in hard, but partly still in plastic state. During the stage of loosed material content the bauxite turned into of detrital fluidal character. Since these phenomena can be recognized within the major part of the bauxite body, it is reasonable to suppose a periodical accumulation of the bauxitic material, specially as the subsequent loosening within a thick bauxite deposit is hard to conceive. It is suggested also by the distribution of the detrital fraction by horizons, showing the variable intensity of the transportation. The small number of the usually primitive oöids found in the bauxite, as well as the dominantly boehmitic character suggest that there was no considerable water infiltration causing strong outwashing in this area, thus pisoidic bauxite could have not formed in greater quantity. The micro-grained, pelitomorphic, scarcely detrital bauxite of the uppermost part of the body deposited in partly stagnant water.

The bauxite accumulation was followed by pyritization, iron-mobilization. The hydrogene sulfidic substance of the foregoing swamp interval of the Upper Lutetian transgression led to formation of grey bauxite. On the other hand the subsequent tectonic movements brought certain parts of the bauxite body into strongly oxidative environment, oxidizing in this way the pyritic bauxite material, and — in the way of sulfidic acid formation — caused iron-content mobilization within the bauxite material situated in deeper horizons. Conclusively the bauxite of Rákhegy is a result of the autochtonous bauxitization of bauxitic clayey wash, and the re-deposition of previously formed bauxite. On the basis of its detrital mineral content, all of the rocks can be assumed as parent rock which were exposed to the erosional processes during the bauxite accumulation (carbonate rocks, clays, sandstones, metamorphic and magmatic rocks and their detritus).

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